

NASA TM X- 55702

DUAL FREQUENCY (20.0-19.9 kHz) VLF DATA

BY

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Hard copy (HC)

Microfiche (MF)

653 July 85

JANUARY 1967

NASA

GODDARD SPACE FLIGHT CENTER

GREENBELT, MARYLAND

N 67 - 18770

FACILITY FORM 602

(ACCESSION NUMBER)

(PAGES)

(NASA CR OR TMX OR AD NUMBER)

(THRU)

(CODE)

(CATEGORY)

X-520-67-35

DUAL FREQUENCY (20.0 - 19.9 kHz) VLF DATA

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Advanced Development Division

January 1967

Goddard Space Flight Center
Greenbelt, Maryland

DUAL FREQUENCY (20.0 - 19.9 kHz) VLF DATA

Data is now available from twelve months of operation of radio station WWVL transmitting 20.0 kHz and 19.9 kHz. The 20.0 kHz signal is controlled by the Boulder Laboratories of NBS so that a particular positively-sloped zero crossing is always synchronous with the NBS master clock to within 1.0 microsecond. The 19.9 kHz transmission is also controlled so that a particular positively-sloped zero crossing is synchronous with a particular positively-sloped zero crossing of the 20.0 kHz transmission to within 1.0 microsecond. Daily measurements of the 20.0 and 19.9 kHz transmissions are available from NBS,^{1,2} and can be used to remove certain systematic variations so that the 19.9 kHz and 20.0 kHz differential phase angle as transmitted can be known to less than 0.2 microsecond.

The instrumentation at GSFC uses a Hewlett Packard cesium-beam frequency standard, two Tracor VLF receivers and a Tracor VLF calibrator. The H-P cesium standard was measured periodically against two Varian hydrogen masers and is known to have a frequency constant to within a few parts in 10^{12} .

Tables 1 through 12 contain daily measurements of the 20.0 kHz and 20.0/19.9 kHz signal phase angles corrected in accordance with the NBS measurements. The 20.0/19.9 kHz data is a function of the phase angle of the 100 Hz information inherent in the 20.0/19.9 transmissions. This data can be used to resolve the 50 microsecond ambiguity inherent in 20.0 kHz single frequency transmissions.³

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1. 20.0 kHz data is in "Time and Frequency Service Bulletin", Radio Standards Laboratory, NBS, Boulder, Colorado, 80302, published monthly.
 2. 19.9 kHz data is available from Section 251.04, Radio Standards Laboratory, NBS, Boulder, Colorado, 80302.
 3. C. H. Looney and L. Fey, "A Dual Frequency VLF Timing System," IEEE Transactions on Instrumentation and Measurement, Vol. IM-16, Dec. 1966.

The columns titled "5-Day Average" are the averages of the daily measurements for the period starting two days before and ending two days after the date of entry. Figure 1 is a plot of the 20.0/19.9 kHz data for 1966. The heavy lines at -9.4 and -9.6 microseconds outline the area corresponding to a coarse differential time between the GSFC clock and WWVL, as received, of 161 cycles of the 20 kHz transmission or 8050 microseconds.

The GSFC clock was synchronized with the NBS clock operated in the NBS Boulder Laboratories, by means of portable clock measurements. The difference between GSFC clock time and WWVL time, as received, is therefore very nearly equal to the VLF propagation time. This propagation time has been calculated by various methods, and ranges from 8043 microseconds for the simplest approach using the great circle distance divided by the speed of light in a vacuum, to 8061 microseconds using techniques described by Wait and Spies.⁴

The column titled "Week Average" is the average of daily measurements for the week ending on the date of entry. The "Month Average" is the average of all daily measurements made during that calendar month. Figure 2 is a plot of this data for 1966. Crosshatched areas outline permissible phase variations corresponding to complete ambiguity resolution and resolution to within three cycles or ± 50 microseconds ambiguity.

The "noise rms" value is the root-mean-square of the difference between daily measurements and the monthly average for that calendar month. Figure 3

4. J. R. Wait and K. P. Spies, "Characteristics of the Earth Ionosphere Waveguide for VLF Waves", NBS Technical Note No. 300, Dec. 30, 1964.

is a plot of this data for 1966 together with a plot of solar activity as reported by the Environmental Science Services Administration.⁵ Figure 4 is a plot of VLF noise versus solar activity, with each type of data averaged quarterly, indicating the correlation between solar activity and VLF noise.

Figure 5 is a plot of the 5-day average 20.0 kHz data indicating the ease with which frequency differences of only a few parts in 10^{12} can be detected. In late June 1966, NBS/Boulder modified their procedures and the resultant frequency shift of approximately four in 10^{12} is apparent.

5. "Solar-Geophysical Data", ESSA, Boulder, Colorado, 80302; published monthly.

VLF DATA (usec.)

1966 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
January	1	--	--	--	--	
	2	--	--	--	--	
	3	--	--	--	--	
	4	9.7	9.7	-10.0	-10.0	
	5	10.0	10.8	-9.8	-9.9	
	6	12.7	11.3	--	-9.9	
	7	12.9	11.9	-9.9	-9.9	-9.9
	8	--	13.0	-9.9	-10.0	
	9	--	13.8	-9.9	-9.9	
	10	13.5	14.2	-10.1	-9.9	
	11	15.1	14.9	-9.8	-9.8	
	12	14.1	15.5	-9.7	-9.7	
	13	17.0	16.0	-9.6	-9.6	
	14	17.7	16.3	-9.4	-9.5	-9.8
	15	--	15.7	-9.4	-9.5	
	16	--	15.6	--	-9.6	
	17	12.5	15.0	-9.8	-9.8	
	18	16.5	15.5	-9.8	-9.8	
	19	15.9	16.2	-10.0	-9.8	
	20	17.1	17.1	-9.7	-9.8	
	21	18.8	17.5	-9.7	-9.8	-9.6
	22	--	16.9	-9.9	-9.8	
	23	--	15.9	-9.7	-9.8	
	24	14.7	14.2	-9.9	-9.9	
	25	14.3	14.4	-10.0	-9.9	
	26	13.7	14.6	-9.9	-9.9	
	27	14.9	14.5	-9.9	-10.0	
	28	15.2	14.4	-10.0	-10.0	-9.9
	29	--	15.2	-10.1	-10.0	
	30	--	15.1	-10.2	-10.0	
	31	15.4	15.1	-9.7	-9.9	

-9.8 Monthly Average
0.20 Noise, rms

TABLE 1

VLF DATA (usec.)

1966 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
February	1	14.8	15.0	-9.8	-9.9	
	2	15.3	15.1	-9.8	-9.8	
	3	15.6	15.2	-9.8	-9.9	
	4	15.2	15.4	-10.0	-9.9	-9.9
	5	--	15.8	-10.0	-9.9	
	6	--	16.0	-10.0	-9.9	
	7	16.5	16.6	-9.7	-9.8	
	8	16.4	16.9	-9.6	-9.8	
	9	16.8	17.3	-9.8	-9.7	
	10	18.0	17.4	-9.7	-9.8	
	11	18.6	17.8	-9.8	-9.8	-9.8
	12	--	18.7	-10.0	-9.8	
	13	--	19.5	-9.9	-9.8	
	14	19.6	20.0	-9.7	-9.8	
	15	20.4	20.0	-9.7	-9.7	
	16	20.1	20.0	-9.7	-9.6	
	17	19.9	20.1	-9.5	-9.6	
	18	20.0	20.0	-9.6	-9.6	-9.7
	19	--	20.0	-9.5	-9.6	
	20	--	20.2	-9.6	-9.6	
	21	20.3	21.2	-9.7	-9.7	
	22	--	21.5	-9.8	-9.7	
	23	22.0	21.2	-9.7	-9.7	
	24	22.1	21.6	-9.7	-9.7	
	25	20.6	21.6	-9.6	-9.7	-9.7
	26	--	21.2	-9.6	-9.7	
	27	--	22.0	-9.8	-9.6	
	28	22.2	21.9	-9.7	-9.6	

-9.6 Monthly Average
0.15 Noise, rms

TABLE 2

VLF DATA (usec.)

1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
March 1	23.1	21.6	-9.5	-9.6	
2	20.5	21.8	-9.6	-9.6	
3	20.7	22.0	-9.5	-9.6	
4	22.7	21.7	-9.6	-9.6	-9.6
5	23.2	22.1	-9.8	-9.6	
6	21.5	22.6	-9.6	-9.6	
7	22.3	22.7	-9.7	-9.6	
8	23.5	22.5	-9.4	-9.6	
9	22.8	22.7	-9.6	-9.6	
10	22.3	23.0	-9.6	-9.6	
11	22.7	23.3	-9.6	-9.6	-9.6
12	23.5	23.1	-9.6	-9.6	
13	25.4	23.7	-9.6	-9.7	
14	22.5	23.6	-9.8	-9.6	
15	24.4	24.1	-9.7	-9.4	
16	22.2	24.1	-9.2	-9.5	
17	26.0	24.8	-9.0	-9.4	
18	25.4	25.3	-9.8	-9.5	-9.5
19	25.9	25.9	--	-9.6	
20	27.1	26.0	-9.8	-9.7	
21	24.9	26.3	-9.7	-9.7	
22	26.8	26.3	-9.6	-9.7	
23	26.7	26.0	-9.9	-9.7	
24	25.9	26.9	-9.6	-9.5	
25	25.9	26.8	--	-9.5	-9.7
26	29.0	26.5	--	--	
27	26.6	26.9	--	--	
28	24.9	27.8	--	--	
29	27.9	27.8	--	--	
30	30.5	27.9	--	--	
31	29.1	28.4	--	--	

-9.6 Monthly Average
0.19 Noise, rms

TABLE 3

VLF DATA (usec.)

1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
April 1	17.3	18.0	-8.8	--	--
2	17.2	17.5	--	-9.5	
3	15.8	17.3	-10.2	-9.5	
4	18.3	17.1	-9.4	-9.7	
5	18.1	16.8	-9.6	-9.7	
6	16.1	16.5	--	-9.6	
7	15.5	16.1	-9.5	-9.5	
8	14.6	15.6	-9.8	-9.5	-9.7
9	16.2	15.3	-9.3	-9.5	
10	15.4	15.3	-9.4	-9.4	
11	15.0	15.4	-9.4	-9.4	
12	15.5	15.2	-9.2	-9.3	
13	14.9	15.1	-9.2	-9.3	
14	15.1	15.2	-9.3	-9.2	
15	15.2	15.2	-9.2	-9.3	-9.3
16	15.5	15.4	-9.1	-9.3	
17	15.4	--	-9.6	-9.3	
18	--	--	--	--	
19	--	--	--	--	
20	--	--	--	--	
21	--	--	--	--	
22	--	--	--	--	-9.4
23	--	--	--	--	
24	--	--	--	--	
25	13.7	--	-9.3	-9.4	
26	12.0	12.3	--	-9.4	
27	11.3	11.9	-9.6	-9.4	
28	11.0	11.4	-9.4	-9.4	
29	11.5	11.3	-9.4	-9.4	-9.4
30	--	11.4	--	-9.5	

-9.4 Monthly Average
0.28 Noise, rms

TABLE 4

VLF DATA (usec.)					
1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
May 1	--	11.5	--	-9.5	
2	11.7	11.4	-9.6	-9.5	
3	11.3	11.5	-9.4	-9.5	
4	11.3	11.4	-9.4	-9.6	
5	11.9	11.2	-9.7	-9.6	
6	10.7	11.2	-9.7	-9.6	-9.6
7	11.0	11.4	-9.6	-9.7	
8	--	11.5	--	-9.6	
9	11.9	11.7	-9.7	-9.6	
10	12.6	11.9	-9.5	-9.7	
11	11.2	11.8	-9.8	-9.6	
12	12.0	12.0	--	-9.6	
13	11.5	12.0	-9.5	-9.6	-9.6
14	12.9	12.3	-9.4	-9.6	
15	12.5	12.5	--	-9.5	
16	12.8	12.9	-10.0	-9.5	
17	13.0	12.9	-9.2	-9.5	
18	13.1	13.1	-9.5	-9.6	
19	12.9	13.1	-9.4	-9.5	
20	13.7	13.2	-9.7	-9.6	-9.5
21	13.0	13.5	-9.8	-9.6	
22	13.5	13.6	--	-9.6	
23	14.3	13.8	-9.4	-9.5	
24	--	14.1	--	-9.3	
25	14.5	14.3	-9.3	-9.3	
26	14.1	14.3	-9.2	-9.4	
27	14.2	14.7	-9.2	-9.4	-9.4
28	14.3	14.9	-9.6	-9.4	
29	16.3	15.1	--	-9.4	
30	15.5	15.5	-9.6	-9.5	
31	15.4	15.9	-9.3	-9.4	
-9.4 Monthly Average					
0.21 Noise, rms					

TABLE 5

VLF DATA (usec.)

1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
June 1	15.8	15.9	-9.4	-9.4	
2	16.3	16.2	-9.4	-9.4	
3	16.5	16.5	-9.5	-9.4	-9.5
4	16.9	16.6	-9.4	-9.4	
5	16.9	17.0	--	-9.4	
6	16.6	17.0	-9.4	-9.4	
7	18.2	16.9	-9.5	-9.4	
8	16.5	16.5	-9.3	-9.4	
9	16.3	16.4	-9.4	-9.5	
10	15.0	15.8	-9.6	-9.4	-9.4
11	16.2	15.7	-9.5	-9.5	
12	15.0	15.4	--	-9.5	
13	15.8	15.6	-9.5	-9.5	
14	15.2	15.6	--	-9.5	
15	15.8	15.7	-9.7	-9.5	
16	16.0	15.8	-9.5	-9.5	
17	15.9	15.9	-9.4	-9.5	-9.5
18	16.0	15.9	-9.5	-9.5	
19	16.0	16.1	-9.6	-9.5	
20	15.7	16.1	-9.6	-9.5	
21	16.7	16.3	--	-9.4	
22	16.1	16.7	-9.2	-9.3	
23	17.2	17.4	-9.2	-9.2	
24	17.8	18.1	-9.0	-9.2	-9.3
25	19.2	18.7	-9.3	-9.3	
26	20.0	19.3	-9.4	-9.3	
27	19.1	19.9	-9.4	-9.3	
28	20.6	20.4	-9.4	-9.3	
29	20.8	20.7	-9.2	-9.4	
30	21.5	21.3	-9.3	-9.4	

-9.4 Monthly Average

0.15 Noise, rms

TABLE 6

VLF DATA (usec.)

1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
July 1	21.5	21.7	-9.6	-9.4	-9.4
2	22.0	22.2	-9.4	-9.5	
3	22.7	22.8	-9.5	-9.5	
4	23.1	23.3	-9.5	-9.5	
5	24.9	23.8	--	-9.5	
6	23.7	24.1	-9.7	-9.6	
7	24.8	24.6	-9.4	-9.6	
8	24.0	24.8	-9.7	-9.6	-9.5
9	25.8	25.2	-9.7	-9.6	
10	25.9	25.6	-9.6	-9.6	
11	25.7	26.4	-9.5	-9.6	
12	26.8	26.5	-9.5	-9.6	
13	27.6	26.6	-9.7	-9.6	
14	26.3	27.0	-9.8	-9.6	
15	26.4	27.1	-9.7	-9.7	-9.6
16	27.9	27.0	-9.5	-9.6	
17	27.1	27.4	-9.7	-9.6	
18	27.2	28.0	-9.4	-9.5	
19	28.3	28.3	--	-9.5	
20	29.4	28.9	-9.4	-9.4	
21	29.7	29.6	-9.3	-9.4	
22	30.1	30.0	-9.3	-9.4	-9.4
23	30.4	30.2	-9.4	-9.4	
24	30.4	30.4	-9.6	-9.4	
25	30.6	30.6	-9.3	-9.4	
26	30.3	30.7	-9.3	-9.4	
27	31.2	31.0	-9.5	-9.3	
28	31.2	31.3	-9.5	-9.3	
29	31.7	31.7	-9.0	-9.2	-9.4
30	32.1	31.8	-8.9	-9.0	
31	32.4	31.8	-8.8	-9.0	

-9.4 Monthly Average
0.24 Noise, rms

TABLE 7

VLF DATA (usec.)

1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
August 1	31.8	31.5	-8.9	-9.1	
2	31.2	31.1	-9.3	-9.2	
3	29.9	30.8	-9.6	-9.4	
4	30.3	30.6	-9.5	-9.5	
5	31.0	30.5	-9.5	-9.5	-9.2
6	30.4	30.9	-9.6	-9.6	
7	31.0	31.1	-9.5	-9.5	
8	31.8	31.2	-9.7	-9.6	
9	31.2	31.4	-9.3	-9.6	
10	31.4	31.9	-9.9	-9.7	
11	31.8	31.9	-9.8	-9.7	
12	33.2	32.0	-9.6	-9.8	-9.6
13	31.8	32.7	-9.9	-9.7	
14	--	33.4	--	-9.7	
15	34.1	34.0	-9.6	-9.5	
16	34.6	34.8	--	-9.4	
17	35.6	35.1	-9.2	-9.4	
18	34.9	35.6	-9.3	-9.2	
19	36.2	36.3	-9.4	-9.2	-9.5
20	36.9	36.7	-9.0	-9.2	
21	37.7	37.1	-8.9	-9.3	
22	37.7	37.4	-9.4	-9.3	
23	36.9	37.7	-9.7	-9.4	
24	37.9	37.7	-9.4	-9.5	
25	38.3	38.1	-9.8	-9.5	
26	37.8	38.6	-9.2	-9.4	-9.3
27	39.4	38.9	-9.3	-9.4	
28	39.7	39.4	-9.3	-9.3	
29	39.1	39.4	-9.4	-9.5	
30	40.2	39.2	--	-9.5	
31	38.5	38.9	-9.9	-9.8	

-9.4 Monthly Average

0.28 Noise, rms

TABLE 8

VLF DATA (usec.)

1966 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
September	1	38.3	38.7	-10.1	-10.0	
	2	38.3	38.6	-10.0	-10.0	-9.7
	3	38.2	38.7	-9.9	-9.9	
	4	39.7	38.9	-9.9	-9.8	
	5	39.2	38.8	-9.8	-9.8	
	6	39.2	38.8	-9.6	-9.7	
	7	37.6	38.1	-9.6	-9.6	
	8	38.1	37.8	-9.4	-9.5	
	9	36.6	37.8	-9.5	-9.4	-9.7
	10	37.4	38.3	-9.3	-9.4	
	11	39.4	38.7	-9.4	-9.4	
	12	39.9	39.4	-9.3	-9.4	
	13	40.1	39.9	-9.4	-9.5	
	14	40.4	40.0	-9.7	-9.6	
	15	39.9	40.1	-9.8	-9.6	
	16	39.6	40.2	-9.6	-9.6	-9.5
	17	40.7	39.8	-9.5	-9.6	
	18	40.6	39.2	-9.6	-9.5	
	19	38.0	38.9	-9.4	-9.5	
	20	37.0	38.6	-9.5	-9.5	
	21	38.3	38.4	-9.3	-9.4	
	22	39.0	38.8	-9.5	-9.4	
	23	39.6	39.3	-9.4	-9.4	-9.5
	24	40.3	40.1	-9.5	-9.5	
	25	--	40.4	--	-9.5	
	26	41.6	40.9	-9.6	-9.5	
	27	--	41.9	--	-9.5	
	28	41.8	42.3	-9.3	-9.4	
	29	42.3	42.8	-9.5	-9.3	
	30	43.5	43.1	-9.2	-9.3	-9.4

-9.6 Monthly Average
0.23 Noise, rms

TABLE 9

VLF DATA (usec.)

1966 Month Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
October 1	43.5	43.8	-9.2	-9.2	
2	44.5	44.7	-9.2	-9.2	
3	45.4	45.1	-9.1	-9.2	
4	46.8	45.5	-9.1	-9.2	
5	45.3	46.0	-9.4	-9.3	
6	45.6	46.2	-9.3	-9.4	
7	46.8	46.5	-9.5	-9.4	-9.3
8	46.6	47.1	-9.5	-9.4	
9	48.3	47.4	--	-9.4	
10	48.0	47.7	-9.2	-9.5	
11	--	47.8	--	-9.7	
12	47.9	48.2	-9.7	-9.9	
13	47.1	48.9	-10.2	-10.1	
14	49.6	49.3	-10.4	-10.1	-9.8
15	50.9	49.9	-10.1	-10.2	
16	51.1	50.7	-10.0	-10.1	
17	50.9	51.0	-10.1	-10.0	
18	51.2	51.3	-10.0	-10.0	
19	51.1	52.0	-10.0	-9.9	
20	52.1	52.6	-9.8	-9.8	
21	4.7	3.0	-9.6	-9.7	-9.9
22	3.8	3.8	-9.4	-9.6	
23	3.5	4.2	-9.8	-9.5	
24	4.9	4.4	-9.3	-9.5	
25	--	5.6	--	-9.5	
26	5.3	6.5	-9.6	-9.4	
27	8.7	7.0	-9.3	-9.5	
28	7.1	7.0	-9.5	-9.5	-9.5
29	--	8.7	--	-9.5	
30	--	8.9	--	-9.6	
31	10.4	10.4	-9.6	-9.6	

-9.6 Monthly Average
0.35 Noise, rms

TABLE 10

VLF DATA (usec.)

1966 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
November	1	9.0	10.9	-9.6	-9.5	
	2	11.7	11.3	-9.7	-9.3	
	3	12.6	11.4	-9.2	-9.2	
	4	12.9	12.0	-8.4	-9.1	-9.3
	5	10.6	12.2	-9.2	-9.0	
	6	12.2	12.5	-9.0	-9.1	
	7	12.9	12.5	-9.3	-9.4	
	8	13.7	13.6	-9.7	-9.6	
	9	12.9	14.6	-9.8	-9.7	
	10	16.2	15.3	-10.2	-9.8	
	11	17.1	15.9	-9.6	-9.6	-9.5
	12	16.5	17.0	-9.5	-9.4	
	13	16.8	17.5	-9.0	-9.3	
	14	18.3	17.6	-8.9	-9.2	
	15	18.6	18.2	-9.3	-9.2	
	16	--	19.2	--	-9.2	
	17	18.9	19.6	-9.5	-9.3	
	18	21.1	20.0	-9.2	-9.3	-9.2
	19	19.9	20.2	-9.2	-9.2	
	20	20.2	20.9	-9.1	-9.2	
	21	20.7	21.1	-9.1	-9.2	
	22	22.7	22.2	-9.2	-9.2	
	23	22.0	22.9	-9.3	-9.1	
	24	25.3	23.8	-9.1	-9.2	
	25	23.6	24.2	-8.9	-9.2	-9.1
	26	25.3	24.3	-9.5	-9.4	
	27	24.8	24.2	-9.4	-9.6	
	28	22.4	24.5	-9.9	-9.8	
	29	24.7	25.0	-10.2	-9.8	
	30	25.3	25.6	-9.8	-9.8	

-9.4 Monthly Average

0.39 Noise, rms

TABLE 11

VLF DATA (usec.)

1966 Month	Day	20.0 kHz Phase	5-Day Average	20.0/19.9 kHz Phase	5-Day Average	Week Average
December	1	27.7	25.6	-9.7	-9.7	
	2	27.8	25.6	-9.6	-9.6	-9.7
	3	22.7	26.3	-9.4	-9.5	
	4	24.4	26.8	-9.5	-9.3	
	5	29.1	26.3	-9.2	-9.3	
	6	30.0	26.6	-9.0	-9.4	
	7	25.4	26.0	-9.6	-9.4	
	8	24.1	24.9	-9.6	-9.5	
	9	21.6	24.4	-9.6	-9.6	-9.4
	10	23.4	25.4	-9.6	-9.6	
	11	27.5	25.7	-9.7	-9.6	
	12	30.3	27.1	-9.5	-9.6	
	13	25.7	27.5	-9.4	-9.6	
	14	28.7	27.1	-9.8	-9.6	
	15	25.2	26.6	-9.7	-9.7	
	16	25.6	28.0	-9.7	-9.7	-9.6
	17	28.0	28.3	-9.7	-9.7	
	18	32.3	29.6	-9.6	-9.6	
	19	30.5	30.5	-9.4	-9.5	
	20	31.6	31.3	-9.5	-9.5	
	21	30.3	30.9	-9.3	-9.5	
	22	32.0	31.2	-9.6	-9.6	
	23	30.2	31.2	-9.7	-9.6	-9.5
	24	32.0	31.8	-9.8	-9.6	
	25	31.5	32.1	-9.4	-9.6	
	26	33.3	32.0	-9.6	-9.6	
	27	33.4	31.6	-9.6	-9.6	
	28	29.6	31.3	-9.6	-9.7	
	29	30.3	30.5	-9.8	-9.7	
	30	29.9	--	-9.7	-9.6	-9.6
	31	29.5	--	-9.7	-9.5	

-9.6 Monthly Average
0.18 Noise, rms

TABLE 12

20.0 / 19.9 (5 DAY AVERAGE) FOR 1966

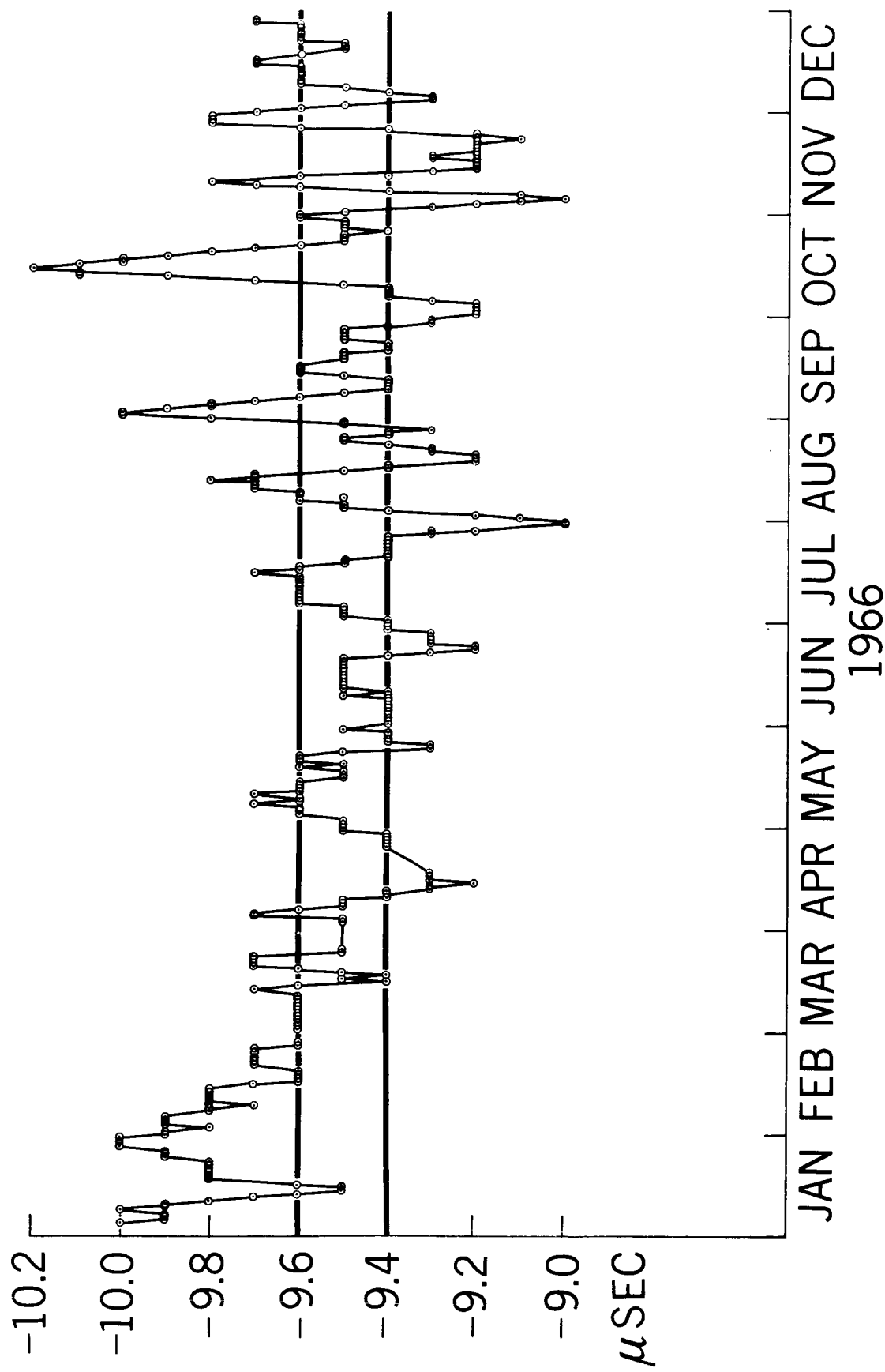


FIGURE 1

20.0/19.9 WEEKLY & MONTHLY AVERAGES

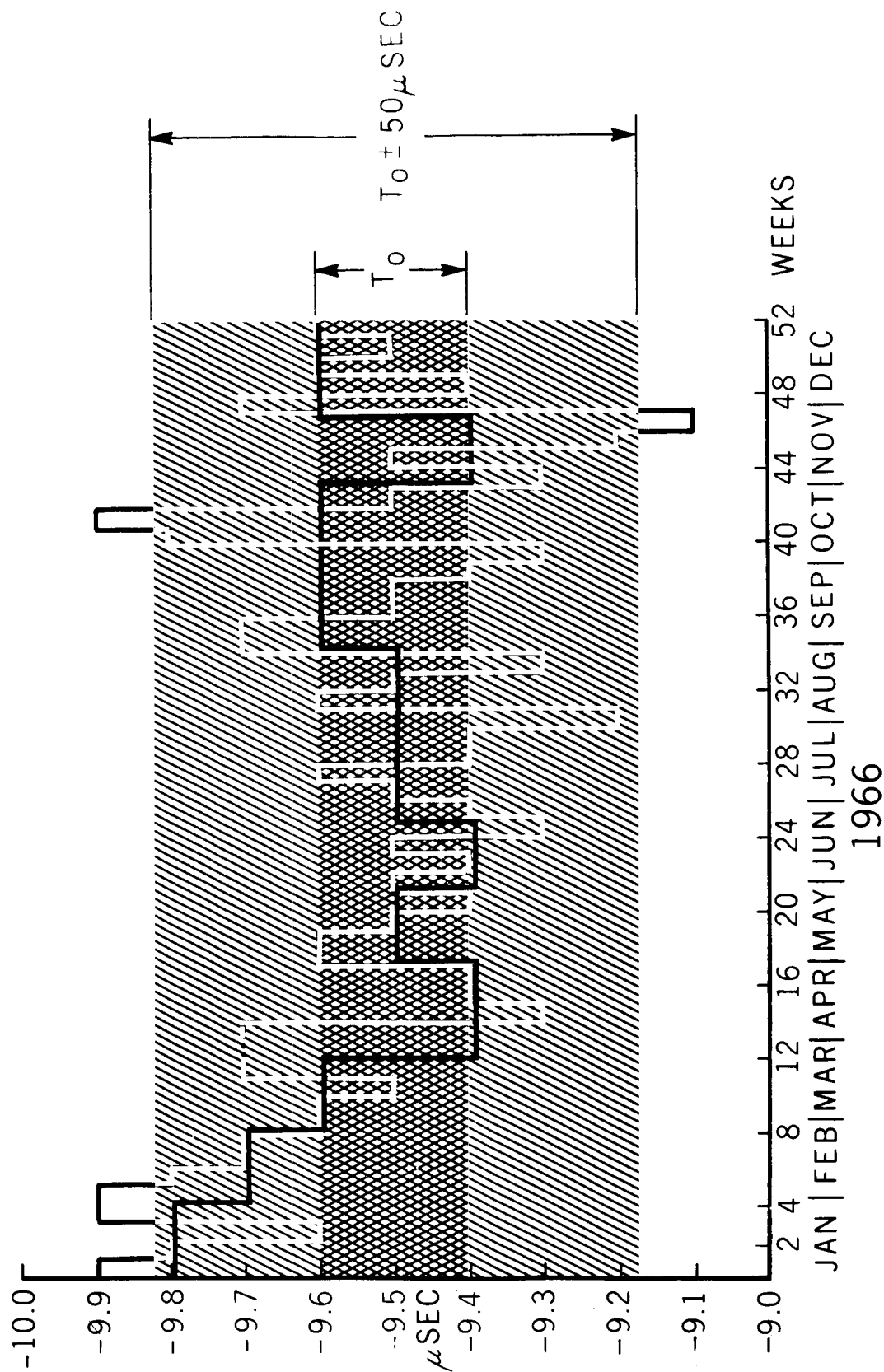


FIGURE 2

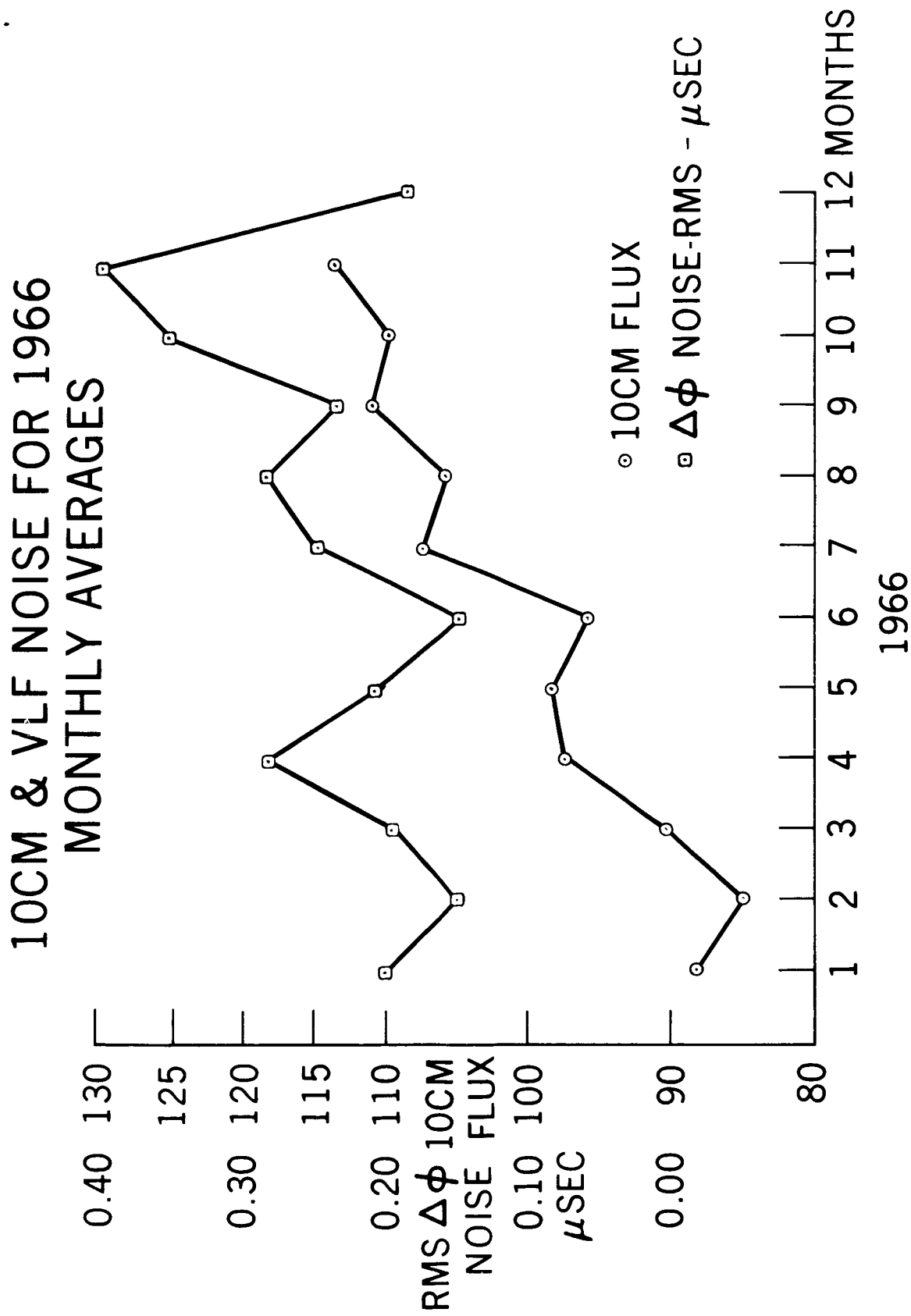


FIGURE 3

10CM FLUX VERSUS VLF NOISE QUARTERLY AVERAGES

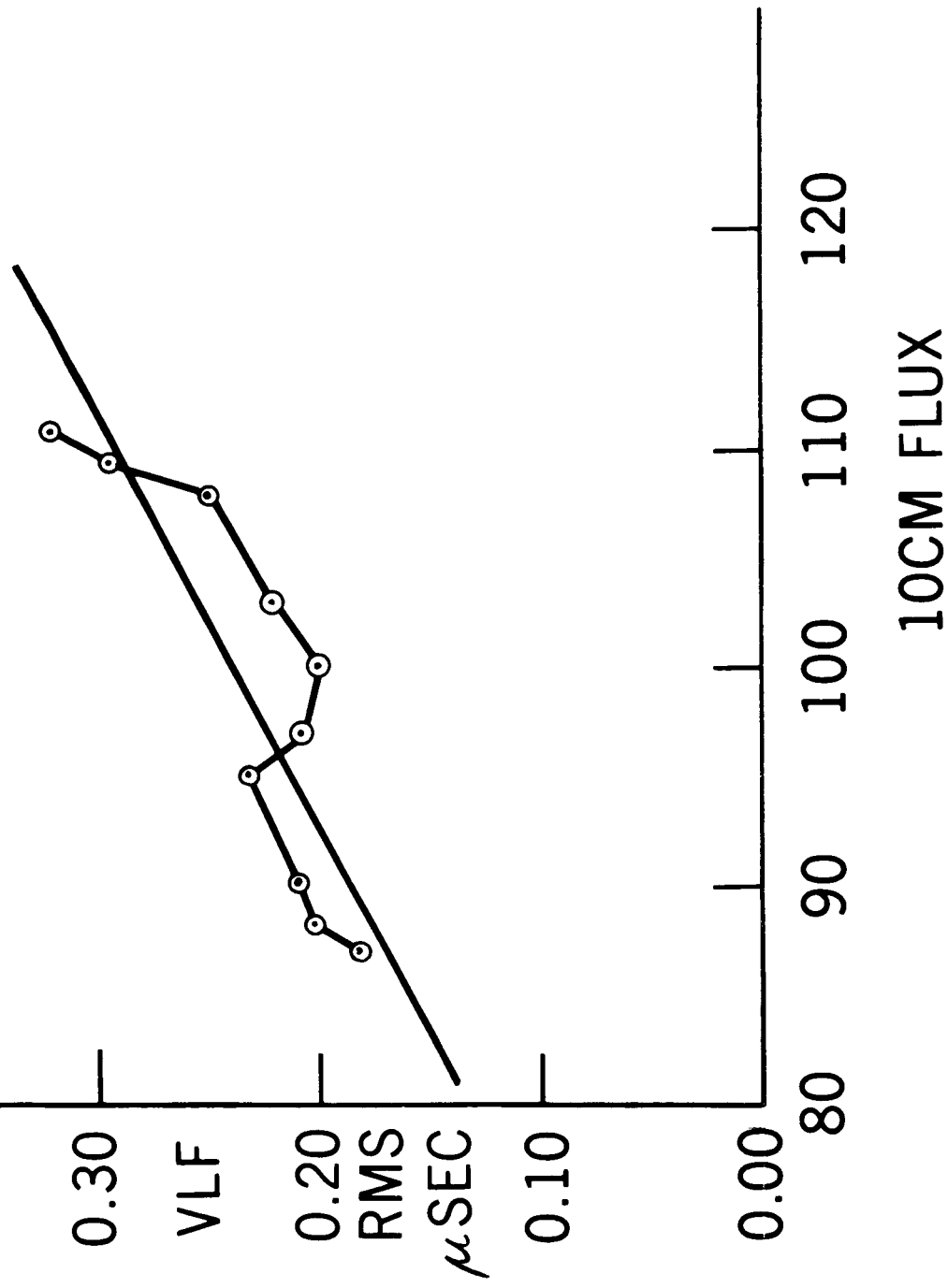


FIGURE 4

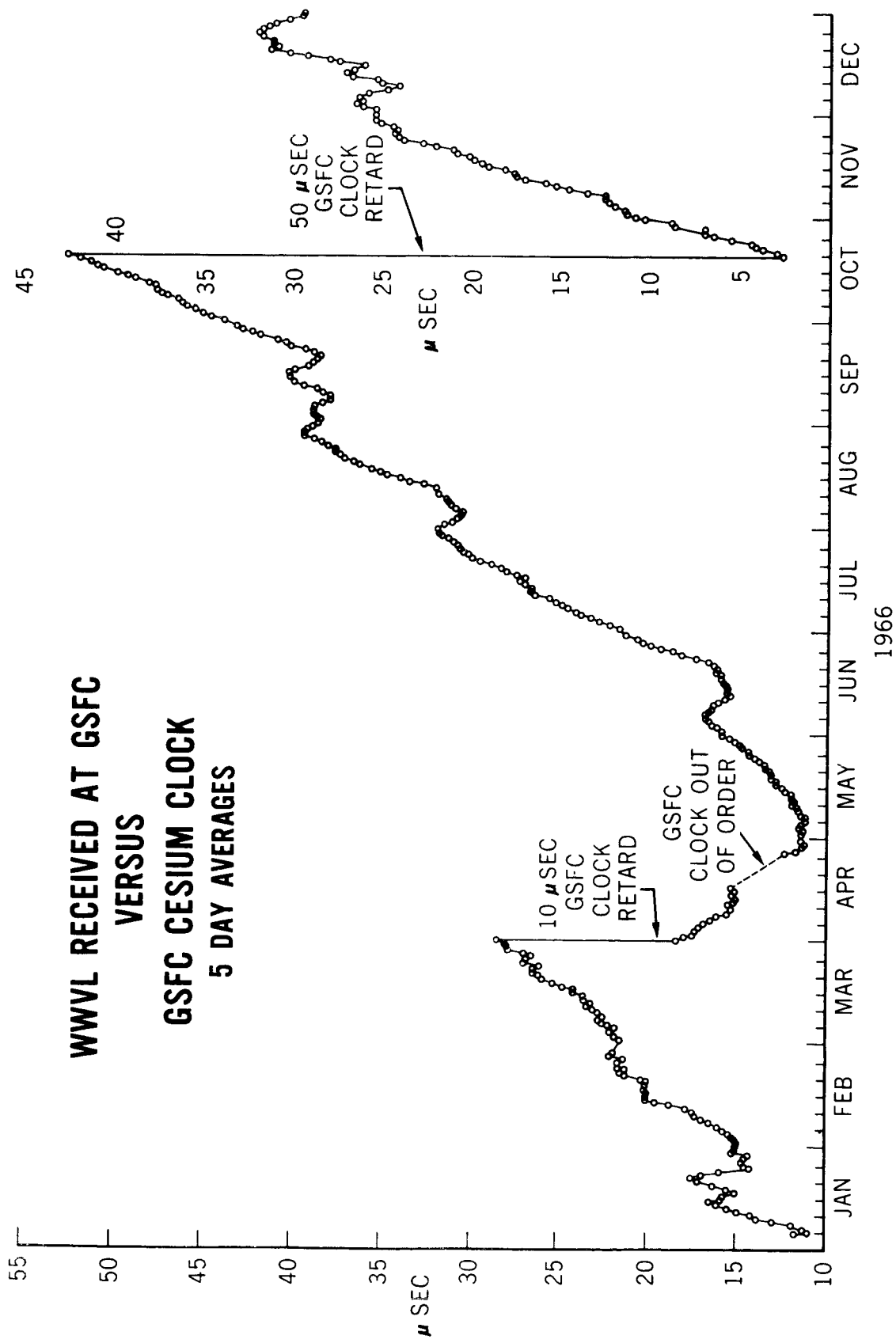


FIGURE 5